FINAL-ET 37 - Electrician Theory Examination Marking Schedule

Notes: 1. (1 mark) means that the preceding statement/answer earns 1 mark.

2. This schedule sets out the accepted answers to the examination questions. A marker can exercise their discretion and decide on the overall accuracy of any answer that is presented in the candidate's own words.

3. Symbols and terms - alternatives

Power	W or P
Voltage	V or E or U
Phase	Active

Question 1	*Reference Marks*	*Marking notes*
(a) (i) Any ONE of: • √3 Power factor • 3 Power factor	(1 mark)	
(ii) Any ONE of: • Voltage Current • Voltage Resistance • Current Resistance	(1 mark)	
(b) (i) Any ONE of: • Split-phase motor • Capacitor start motor • Cap-start, cap-run motor	(1 mark)	
(ii) Any ONE of: • Universal motor • Series motor		
(c) Under fault conditions the earthing of the metal frame keeps the frame of appliance at earth potential.	(2 marks)	
(d) Any TWO of:	(2 marks)	

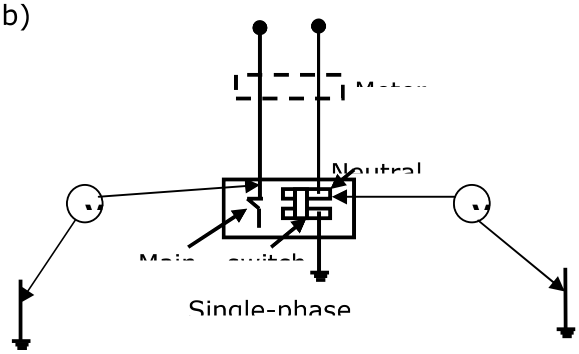
Question 1	*Reference Marks*	*Marking notes*
● Voltage applied. ● Shock current level. ● Contact duration. ● Skin dryness. ● Current path.		
(e) (i) Any ONE of: ● A flash-over could occur on the switchboard due to inadequate kA rating of protective devices ● Damage to the protective devices ● Cannot contain the level of fault current	(1 mark)	
(ii) Any ONE of: ● A fire hazard could occur due to fittings overheating under fault conditions ● Damage to equipment	(1 mark)	
(f) (i) Insulation resistance test	(½ mark)	
(ii) (A) Any ONE of: ● Insulation resistance test function ● 500V d.c	(½ mark)	
(B) Any ONE of: ● The Megohm range ● 500V d.c.	(½ mark)	
(iii) 0.01 MΩ (or 10,000Ω)	(½ mark)	
Alternative		
(i) Circuit resistance test	(½ mark)	
(ii) (A) Ohms scale:	(½ mark)	
(B) Any ONE of: ● Lowest range ● Auto-range.	(½ mark)	
(iii) A reading much higher than expected indicates there is a fault in the circuit.	(½ mark)	
(g) ● To prevent the star and delta contactors closing simultaneously	(1 mark)	
● And causing a short-circuit.	(1 mark)	

Question 1	*Reference Marks*	*Marking notes*
(h) $\text{pf} = \frac{P}{\sqrt{3} \times V \times A}$	(½ mark)	
$= \frac{30000}{\sqrt{3} \times 406 \times 57}$	(½ mark)	
$= 0.748$	(1 mark)	
(ii) Any ONE of: • Pre-arcing time Time taken to melt the fuse elements • Arcing time The time taken between the initiation of the arc and the arc extinguishing • Cut off current The fault current that will cause the fuse to blow • Total clearing time The time it takes to interrupt the flow of current and extinguish the flame.	(1 mark)	
(ii) This is the time it takes to interrupt the flow of current and extinguish the flame.	(1 mark)	
(j) To connect the external resistance to the wound rotor.	(2 marks)	

Question 2	*Reference Marks*	*Marking notes*
(a) • The final subcircuit earth conductor • The main earth bar • The MEN link • The main neutral bar • The consumers main neutral • The distribution neutral • The star point • The white active (phase) conductor • The main switch • The switchboard cables • The protective device • The final subcircuit active conductor	(6 marks)	The objective is for the candidate to describe the loop in their own words
(b) $I_F = \frac{V}{Z}$	(½ mark)	
$= \frac{230}{0.32}$	(½ mark)	
$= 718.75A$	(1 mark)	
(c) (i) • The earth bar • The earth electrode	(1 mark)	
(ii) Tags warning against disconnection	(1 mark)	

Question 3	*Reference Marks*	*Marking notes*
(a) $V_{ph} = \frac{V_l}{\sqrt{3}}$	(½ mark)	
$= \frac{400}{\sqrt{3}}$	(½ mark)	
$= 230.9V$	(1 mark)	
$\frac{N_s}{N_p} = \frac{V_s}{V_p}$		
$V_p = \frac{N_p \times V_s}{N_s}$	(½ mark)	
$= \frac{142.95 \times 230.9}{1}$	(½ mark)	
$= 33007V$	(1 mark)	
(b) $kVA = \frac{V_1 \times I_L \times \sqrt{3}}{1000}$	(½ mark)	Accept calculations based on 33000V
$= \frac{33007 \times 4.37 \times \sqrt{3}}{1000}$	(½ mark)	
$= 249.92kVA$	(1 mark)	
(c) $I_L = \frac{VA}{(V_1 \times \sqrt{3})}$	(½ mark)	Accept calculations based on 250kVA
$\frac{249920}{(400 \times \sqrt{3})}$	(½ mark)	
$= 360.07A$	(1 mark)	
Alternative		
$= \frac{V_N}{3 \times V_P}$		
$= \frac{249.92}{3 \times 230.9}$		
$= 360.7A$		
(d) Regulation % $= \frac{V_{NL} - V_{FL} \times 100}{V_{NL}}$	(½ mark)	Accept calculations based on 230V
$= \frac{230.9 - 222 \times 100}{230.9}$	(½ mark)	
$= 3.85\%$	(1 mark)	
Alternate		
Regulation % $= \frac{V_{NL} - V_{FL} \times 100}{V_F}$		
$= \frac{230.9 - 222 \times 100}{222 \qquad 1}$		
$= 4\%$		

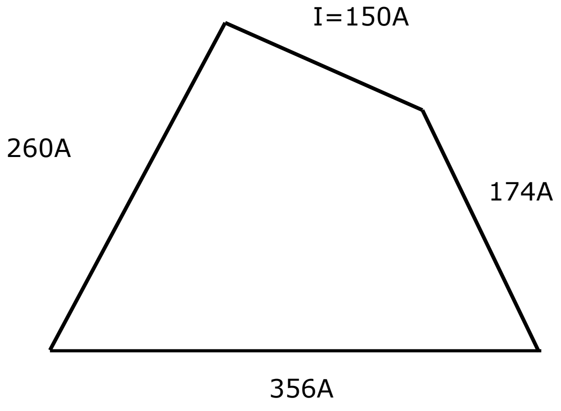
Question 4	*Reference Marks*	*Marking notes*
(a) (i) 30 milliamps. (ii) 10 milliamps (iii) Between 100 milliamps and 300 milliamps.	(1 mark) (1 mark) (1 mark)	
(b) Because the RCD trips in milliseconds	(1 mark)	
(c) Any ONE of: ● The short circuit does not produce an imbalance between the phase an neutral currents in the RCCB ● The RCCB does not incorporate an overload function.	(2 marks)	
(d) (i) Portable Residual Current Device (ii) ● To ensure that the PRCD opens when supply is lost ● And that it must be manually reset after supply has been restored.	(1 mark) (½ mark) (½ mark)	
(e) Yes The RCD detects the imbalance regardless of the polarity of the supply.	(½ mark) (½ mark)	
(f) RCBO Residual Circuit Breaker with Overcurrent protection SRCD Socket Residual Current Device	(½ mark) (½ mark)	

Question 5	*Reference Marks*	*Marking notes*
(a) (i) a.c. voltage	(½ mark)	
(ii) Any ONE: • A range that will read 230V • Auto range	(½ mark)	
(iii) • A temporary earth stake	(½ mark)	
• An earth lead	(½ mark)	
(b) 		No marks for (b) and (c) if the MEN link is removed
• Testing between the temporary earth and the line side of the main switch	(1 mark)	
• Testing between the temporary earth and a point on the MEN connection.	(1 mark)	
(c) (i) • About 230V between the temporary earth and the line side of the main switch.	(1 mark)	
• About 0V between the temporary earth and the MEN connection.	(1 mark)	
(ii) • About 0V between the temporary earth and the line side of the main switch.	(1 mark)	
• About 230V between the	(1 mark)	

Question 5	*Reference Marks*	*Marking notes*
temporary earth and the MEN connection.		
(d) Any ONE of: • The fault current is too low to blow the fuse. • Because the impedance of the fault loop is too high.	(2 marks)	

Question 6	*Reference Marks*	*Marking notes*
(a) (i) Any TWO of: • Protective earthing conductor test • Insulation resistance test • Correct circuit connections test.	(1 mark)	
(ii) and (iii) The TWO of the following tests relating to the answers to (i) Test 1 – Protective earthing conductor test		
• Ohms function	(½ mark)	
• Lowest range	(½ mark)	
• Test between the PEC conductor of the flexible cord and the frame of the motor	(1 mark)	
• Result of a lot less than 1 ohm	(1 mark)	
Test 2 – Insulation resistance test		
• Any ONE of: - Insulation resistance test function - 500V d.c	(½ mark)	
• Any ONE of: - The Megohm range - 500V d.c.	(½ mark)	
• Test between each conductor of the flexible cord and the frame of the motor	(1 mark)	
• Result of more than 1 Mohm	(1 mark)	
Test 3 – Correct circuit connections test		
• Ohms scale	(½ mark)	
• Any One of: - Lowest range - Auto-range	(½ mark)	
• Connect the instrument between L1 and the motor frame, L2 and motor frame; L3 and motor frame in turn	(1 mark)	
• Each test will show an open circuit between each line and the motor frame.	(1 mark)	
(b) Any ONE of:		
• Ohms function	(½ mark)	
Lowest range	(½ mark)	
Test between the frame of the motor and a known earth other than the	(1 mark)	

Question 6	*Reference Marks*	*Marking notes*
motor circuit The impedance is low enough to ensure the protective device operates	(1 mark)	
- Earth fault loop impedance function	(1 mark)	
Connect the tester between the motor terminal and the frame of the saw.	(2 marks)	
The impedance is low enough to ensure the protective device operates	(1 mark)	

Question 7	*Reference Marks*	*Marking notes*
(a) White phase	(½ mark)	
P = V x I		
= 230 x 173.91	(½ mark)	
= 39999.3W	(1 mark)	
Total power	(½ mark)	
P = R+W+B		
= 60 + 39.99 + 82	(½ mark)	
= 181.99kW	(1 mark)	
(b) Blue phase		There are a number of acceptable alternate methods of answering this question. Calculations can also be carried out using the kW ratings and converting to amps at the end
I = $\frac{P}{V}$		
= $\frac{82000}{230}$	(½ mark)	
= 356.62A	(1 mark)	
Red phase		
I = $\frac{P}{V}$		
= $\frac{60000}{230}$	(½ mark)	
= 260.89A	(1 mark)	
		
• ½ mark for each correct current	(2 marks)	
• I = 150A (accept any answer between 145 and 160A)	(1 mark)	

Question 8	*Reference Marks*	*Marking notes*
(a) 0.82	(½ mark)	
(b) Output kW = HP x 746 = 5.36 x 746 = 4kW	 (½ mark) (1 mark)	Accept answers using 750W in the calculation
(c) Input kW = √3 x V x I x pf = √3 x 415 x 8.52 x 0.82 = 5.022 kW	(½ mark) (½ mark) (1 mark)	
(d) (i) Any ONE of: ● International protection ● Ingress protection	(1 mark)	
(ii) ● Protection against the ingress of solid objects ● Protection against the ingress of dust	(½ mark) (½ mark)	
(iii) Protection against the ingress of water.	(1 mark)	
(e) Any ONE of: ● Delta connection ● DOL starter ● Star/delta starter	(1 mark)	
(f) ● A current larger that the current setting of the thermal overload. ● That is sustained long enough to operate the overload	(1 mark) (1 mark)	

Question 9	*Marks*	*Reference*	*Marking notes*
(a) (i) To stress the insulation at levels above the nominal operating (or peak) voltage.	(1 mark)		
(ii) Any ONE of: • To ensure capacitive or inductive reactance does not influence the test result. • A constant maximum voltage is a more stringent test than the momentary peaks of an a.c. waveform.	(1 mark)		
(b) (i) Either the range or the water heater (or both) have insulation resistance much lower than 1 MΩ	(1 mark)		
(ii) The test method described has to show:			
• The MEN link and main neutral disconnected.	(1 mark)		
• Disconnection of the range and water heater	(1 mark)		
• All switches and circuit breakers in the "ON" position	(½ mark)		
• Testing between live parts and earth	(1 mark)		
• A minimum of 1 MΩ test value for the installation	(½ mark)		
• Testing between phase/neutral and earth of the water heater.	(½ mark)		
A minimum value of 10,000Ω.	(1 mark)		
• Testing between phase/neutral and earth of the range.	(½ mark)		
A minimum value of 10,000Ω.	(1 mark)		